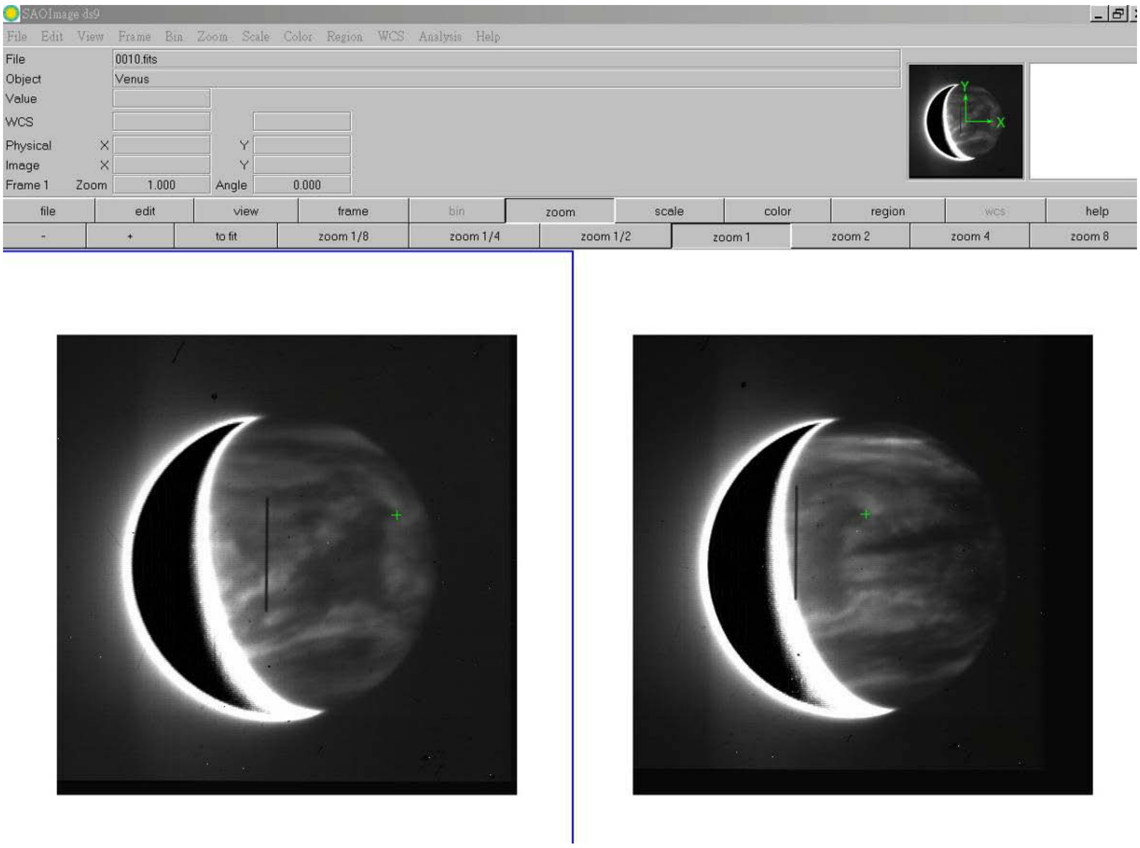
According to what Mark said in today's meeting. I revised my email on Tuesday May 11, 2010, which described the math behind the calculation. I adjusted the 2^{nd} step about the time calculation. Instead of using Time_GPS field, I use **Time_OBS** for both night, and recalculate the time interval. I will upload this file to my folder in our Wiki website. http://wikivm.boulder.swri.edu/mediawiki/index.php/Venus_Winds_Wiki
My folder's location: Main page → 5 Data Download & Upload → Raw Category 1 Images →Sean→WindsSpeedCalculation_UseJuly12_13_asAnExample.pdf

I tried to calculate the winds speed by following Mark's instructions (5-8-10.pdf). I chose 0010.fits for the image of July 12, 2004 and 0212.fits for July 13, 2004. Both are the first images of each night. I also use the same feature, that Mark uses as an example (and I called it a horse head) on page 4 of the pdf file, to mark the green signs on both images. I think using the same feature will help everyone understand better and maybe someone could tell me whether I did it right. You can look at the 2 image below and find out there is a green mark + sign on each Venus image.



I recorded both coordinates as followed:

- July 12(0010.fits) : x1 = 378.500, y1= 312.000
- July 13 (0212.fits): x2 = 259.500, y2= 312.750

Then I followed the instruction to calculate the distance differences, time differences, and the speed. Calculating winds (by the instructions on page 5 of the pdf file)

1. Calculate the distance differences between 2 green marks
    - Delta x = x2- x1 = 259.500-378.500=-119.0 (pixels, I need only distance, so negative sign can be ignored.)
    - Delta y = y2 -y1 = 312.750-312.000=0.75 (pixels)
    - One pixel equals 40,000 meters: s = 40,000
    - Dew (The distance the point has moved in the east-west direction) =s times delta x
        - 40,000 x 119.0 = **4,760,000** (the distance of x coordinates between 2 green marks, in meter)
    - Dns (The distance the point has moved in the north-south direction)= s times delta y
        - 40,000 x delta y = 40,000 x 0.75=**30,000** (the distance of y coordinates between 2 green marks, in meter)
    - Save **Dew** and **Dns** for later calculating the velocity.
2. Calculate the time differences between 2 green marks
    - By looking at the image header of each file, I found out there are 2 time fields in the header. You can look at the 2nd attached file to find the header information for 0010.fits. the image below is the snapshot of image header for 0010.fits:

```
File  Edit
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                  -64 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  512 / length of data axis 1
NAXIS2  =                  512 / length of data axis 2
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode: 2001A&A...376..359H
DATAMIN = '-4706    '          / MIN DATA VALUE IN FILE
DATAMAX = '19615    '          / MAX DATA VALUE IN FILE
DATAMEAN= '0.00     '          / MEAN DATA VALUE IN FILE
DIVISOR = '4        '          / Normalization value
ORIGIN  = 'Institute for Astronomy'
TELESCOP= 'NASA IRTF'
INSTRUME= 'SpeX, IRTF Guider/Camera'
OBSERVER= 'E. Young & M. Bullock'
OBJECT  = 'Venus    '
IRAFNAME= 'data0010.a.fits'
DSPTMFLE= 'none     '          / DSPTimingInfo File
BEAM    = 'A        '          / Object(A) or sky(B)
TIME_OBS= '15:46:52.251578'    / UT TIME OF ACQISTION ('hh:mm:ss.ss')
DATE_OBS= '2004-07-12'         / UT DATE OF ACQUISITION ('yyyy/mm/dd')
TIME_GPS= '46:52.249978'       / UT TIMESTAMP from GPS ('mm:ss.usec')
CAMMODE = '0        '          / CameraMode is Basic
ITIME   = '0.2500   '          / INTEGRATION TIME IN SECONDS
CO_ADDS = '4        '          / NUMBER OF INTEGRATIONS
CYCLES  = '200      '          / Number of cycles
NUMARRAY= '1        '          / Number of data sub-arrays
ARRAY0  = '0,0,512,512'        / x,y,wid,hgt of data sub-arrays
BEAMPAT = '0        '          / Beam Pattern
BBMODE  = '2        '          / BB Mode is BBMODE_D16
CBMODE  = '1        '          / CB Mode is ARC_D
NDR     = '1        '          / Number of Non-Destructive Reads
SLOWCNT = '12       '          / Number of Slow Counts
GRSTCNT = '800      '          / Global Reset Count. 1 cnt = 25 nsec
GPSTMFLG= '1        '          / GPS_Time_Flag
BGRESET = '1,2000,1600'        / Backgroud Reset's flag, msec, cnt
RMEX206 = '0        '          / RemoveExtra206MuxData. MUX206=0
TABLE_MS= '235.508  '          / msec to clock out array
CALMIR  = 'Out      '          / menu=0,pos=252000
```

- In the image header of 0010.fits, there are 2 time information: (middle of the image)
  - 1. TIME_OBS= '15:46:52.251578' / UT TIME OF ACQISTION ('hh:mm:ss.ss')
  - 2. TIME_GPS= '46:52.249978' / UT TIMESTAMP from GPS ('mm:ss.usec')
- TIME_GPS ignores the hour field and is a sight smaller the TIME_OBS. ~~I chose TIME_GPS to use by flipping the coin. No, by my intuition.~~ Mark said using Time_OBS is more appropriate. (12ve Meeting, May 13)
  - t1 (the time of the first observation, The ~~TIME_GPS~~ Tim_OBS in 0010.fits header) = 15:46:52.251578. Convert it to only seconds: 15 hour 46 minute 52.251578 seconds = 15x60 x 60 + 46 x 60 + 52.251578 = 56812.251578 (Seconds); this is the time when 0010.fits was taken on July 12.
  - t2 (the time of the second observation, The ~~TIME_GPS~~ Tim_OBS in 0212.fits header) = 15: 28:15.406058. Convert it to only seconds: 15 hour 28 minute 15.406058 second = 15*60 * 60 + 28*60 + 15.406058 = 55695.406058; this is the time when 0210 fits was taken on July 13.
  - Delta t (the total elapsed time between 2 green marks) = t2 - t1. However, because t2 is on July 13 but t1 is on July 12, we need to add 24 hours, which would be 86, 400 seconds, to the final result. Why plus 24 hours? Here is my explanation:

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- Let's draw a timeline from the beginning of July 12 to the end of July 13
- [July 12 | July 13]
- 12 a.m. 12 a.m. 12 a.m.
- |---------------t1----------|------------------t2------|
- **t1-- --- --|-----------------t2** → This is the goal
- The time interval from the first 12a.m. (July 12) to t1 is 56812.251578
- **|--------------t1**→56812.251578
- The time interval from second 12a.m. (July 13) to t2 is 55695.406058
~~~~~~

- **|-----------------t2→**55695.406058
- My goal is calculate the time interval from t1 to t2, so I use **t2** plus **24 hours,** which would be the time interval from the first 12 a.m. (July 12) to t2
- |--------------------t1-------|-------------------t2
- **| 24 hours |**
- Then minus **t1**.
- **|--------------------t1**
- **t1-------|------------------t2→ the answer**
- Thus, t2 + 24 hours (86,400) -t1 = 55695.406058 + 86,400 - 56812.251578 = **85,283.154480**; this should the **delta t**
- Take an easier example—if I go to bed at 23 o'clock on July 12 and wake up on 8 o'clock on July 13. How long have I slept? The solution should be: t2= 8, t1 = 23, Delta t = t2 - t1 + 24 hours = 8-23 +24 = 9 (hours). I have slept 9 hours from July 12 to 13.

3. Finally, calculate the speed
   - Velocity is distance (difference) divided by time (difference).
   - Now I know the Dew, Dns, and delta t:
     - Dew = 4,760,000 (meter); Dns = 30,000 (meter); delta t = **85,283.154480** (seconds)
   - Vew (the wind velocity in the east-west direction)= Dew /delta t :
     - 4,760,000 / **85,283.154480**=**55.8140705** (meter per second)**---Answer 1**
   - Vns (the wind velocity in the east-west direction)= Dns / Delta t
     - 30,000 / **85,283.154480** = **0.35176935** (meter per second)----**Answer 2**

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